2N7002E

Small Signal MOSFET

60 V, 310 mA, Single, N−Channel, SOT−23

Features

- Low $R_{DS(on)}$
- Small Footprint Surface Mount Package
- Trench Technology
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Low Side Load Switch
- Level Shift Circuits
- DC−DC Converter
- Portable Applications i.e. DSC, PDA, Cell Phone, etc.

MAXIMUM RATINGS (T_J = 25°C unless otherwise stated)

Rating		Symbol	Value	Unit
Drain−to−Source Voltage		V_{DSS}	60	V
Gate−to−Source Voltage		V_{GS}	±20	V
Drain Current (Note 1)		I_D		mA
Steady State	T_A = 25°C		260	
	T_A = 85°C		190	
t < 5 s	T_A = 25°C		310	
	T_A = 85°C		220	
Power Dissipation (Note 1)		P_D		mW
Steady State			300	
t < 5 s			420	
Pulsed Drain Current (t_p = 10 μs)		I_{DM}	1.2	A
Operating Junction and Storage Temperature Range		T_J, T_{STG}	−55 to +150	°C
Source Current (Body Diode)		I_S	300	mA
Lead Temperature for Soldering Purposes (1/8″ from case for 10 s)		T_L	260	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Junction−to−Ambient − Steady State (Note 1)	$R_{\theta JA}$	417	°C/W
Junction−to−Ambient − t ≤ 5 s (Note 1)	$R_{\theta JA}$	300	

1. Surface−mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [1 oz] including traces)

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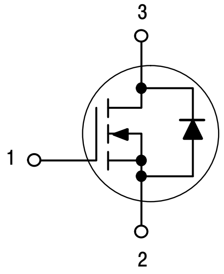
$V_{(BR)DSS}$	$R_{DS(on)}$ MAX	I_D MAX (Note 1)
60 V	3.0 Ω @ 4.5 V	310 mA
	2.5 Ω @ 10 V	

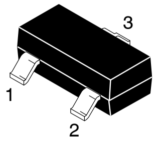
Simplified Schematic

N−Channel

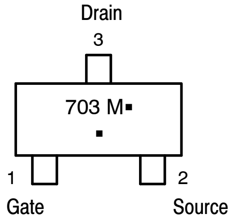


(Top View)

MARKING DIAGRAM & PIN ASSIGNMENT



SOT−23
CASE 318
STYLE 21



703 = Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
2N7002ET1G, S2N7002ET1G	SOT−23 (Pb−Free)	3000 / Tape & Reel
2N7002ET7G, S2N7002ET7G	SOT−23 (Pb−Free)	3500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

June, 2019 − Rev. 7

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified)

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
OFF CHARACTERISTICS							
Drain−to−Source Breakdown Voltage	$V_{(BR)DSS}$	V_{GS} = 0 V, I_D = 250 μA		60			V
Drain−to−Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$				75		mV/°C
Zero Gate Voltage Drain Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = 60 V	T_J = 25°C			1	μA
			T_J = 125°C			500	
Gate−to−Source Leakage Current	I_{GSS}	V_{DS} = 0 V, V_{GS} = ±20 V				±100	nA
ON CHARACTERISTICS (Note 2)							
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS}, I_D = 250 μA		1.0		2.5	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$				4.4		mV/°C
Drain−to−Source On Resistance	$R_{DS(on)}$	V_{GS} = 10 V, I_D = 240 mA			0.86	2.5	Ω
		V_{GS} = 4.5 V, I_D = 50 mA			1.1	3.0	
Forward Transconductance	g_{FS}	V_{DS} = 5 V, I_D = 200 mA			530		mS
CHARGES AND CAPACITANCES							
Input Capacitance	C_{ISS}	V_{GS} = 0 V, f = 1 MHz, V_{DS} = 25 V			26.7	40	pF
Output Capacitance	C_{OSS}				4.6		
Reverse Transfer Capacitance	C_{RSS}				2.9		
Total Gate Charge	$Q_{G(TOT)}$	V_{GS} = 5 V, V_{DS} = 10 V; I_D = 240 mA			0.81		nC
Threshold Gate Charge	$Q_{G(TH)}$				0.31		
Gate−to−Source Charge	Q_{GS}				0.48		
Gate−to−Drain Charge	Q_{GD}				0.08		
SWITCHING CHARACTERISTICS, V_{GS} = V (Note 3)							
Turn−On Delay Time	$t_{d(ON)}$	V_{GS} = 10 V, V_{DD} = 30 V, I_D = 200 mA, R_G = 10 Ω			1.7		ns
Rise Time	t_r				1.2		
Turn−Off Delay Time	$t_{d(OFF)}$				4.8		
Fall Time	t_f				3.6		
DRAIN−SOURCE DIODE CHARACTERISTICS							
Forward Diode Voltage	V_{SD}	V_{GS} = 0 V, I_S = 200 mA	T_J = 25°C		0.79	1.2	V
			T_J = 85°C		0.7		

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%
3. Switching characteristics are independent of operating junction temperatures

TYPICAL CHARACTERISTICS

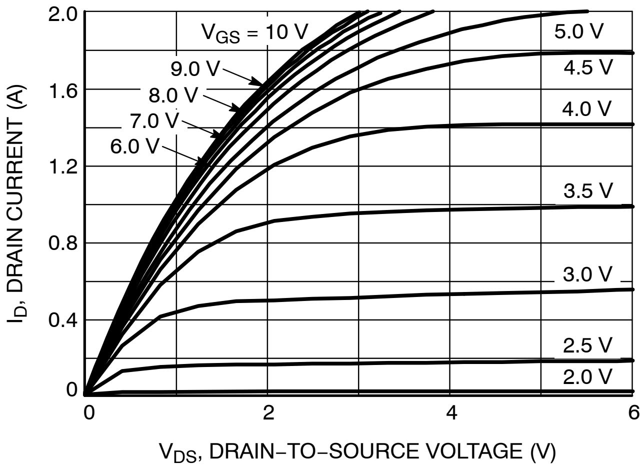


Figure 1. On−Region Characteristics

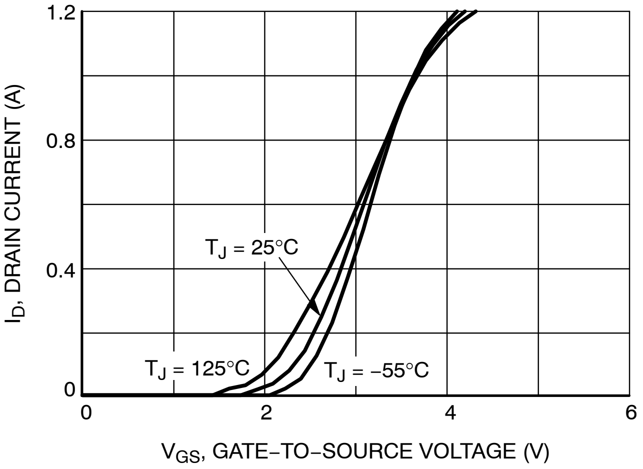


Figure 2. Transfer Characteristics

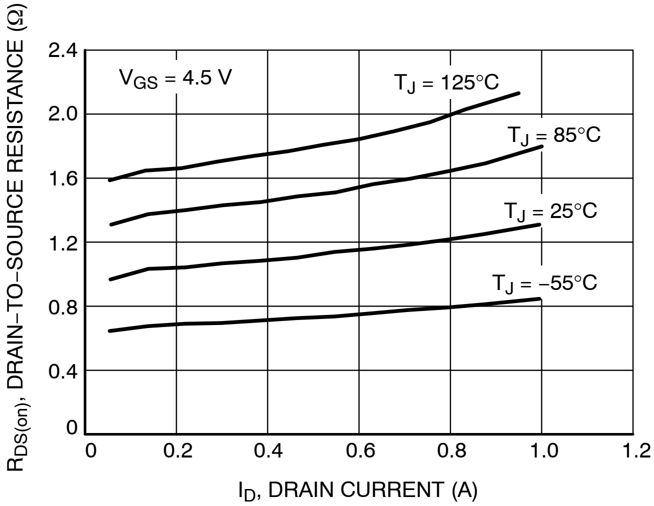


Figure 3. On−Resistance vs. Drain Current and Temperature

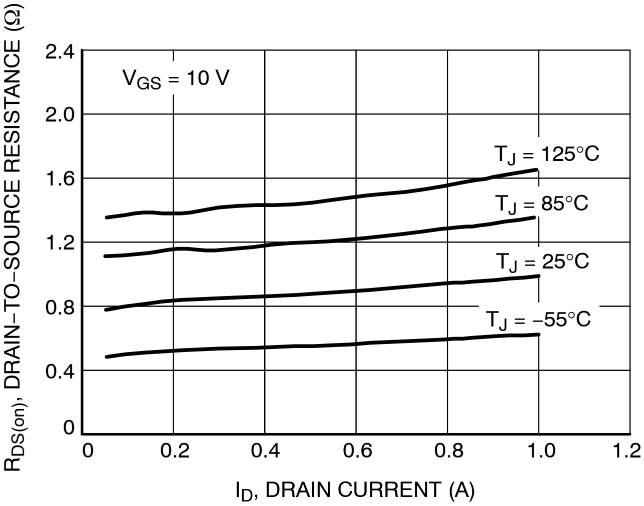


Figure 4. On−Resistance vs. Drain Current and Temperature

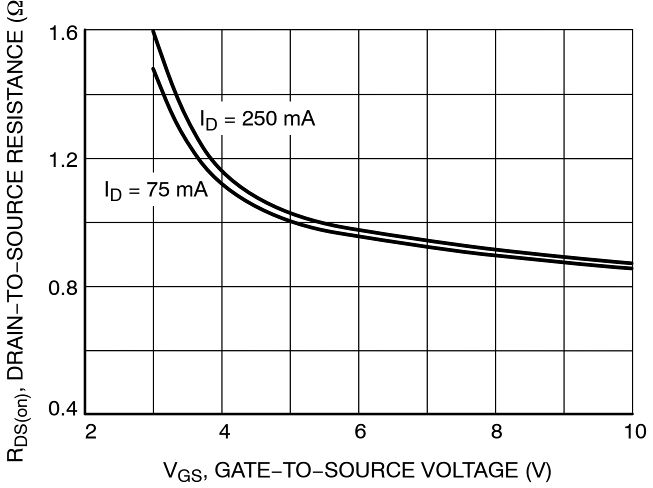


Figure 5. On−Resistance vs. Gate−to−Source Voltage

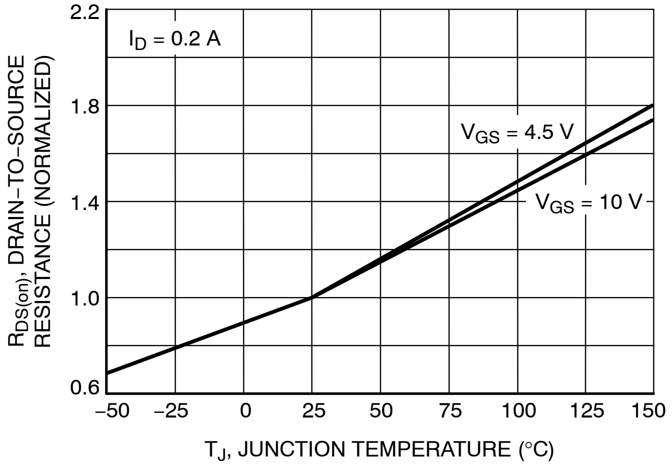


Figure 6. On−Resistance Variation with Temperature

TYPICAL CHARACTERISTICS

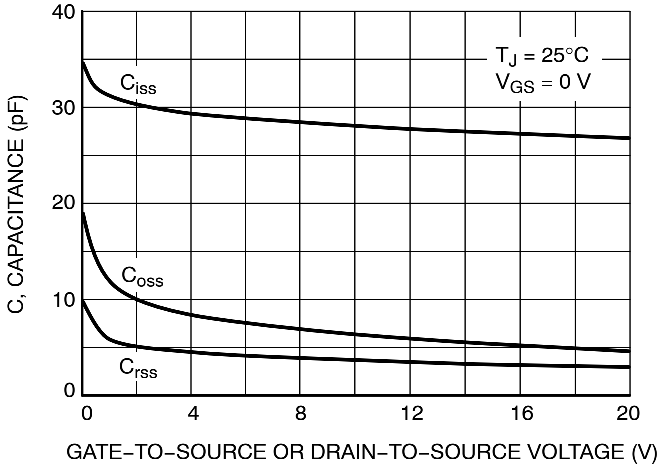


Figure 7. Capacitance Variation

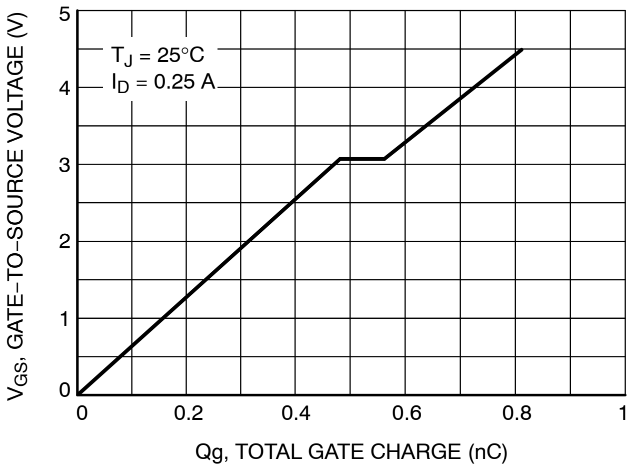


Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge

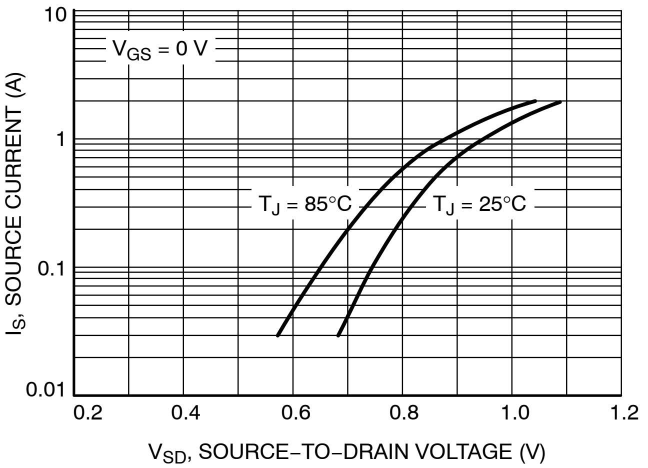


Figure 9. Diode Forward Voltage vs. Current

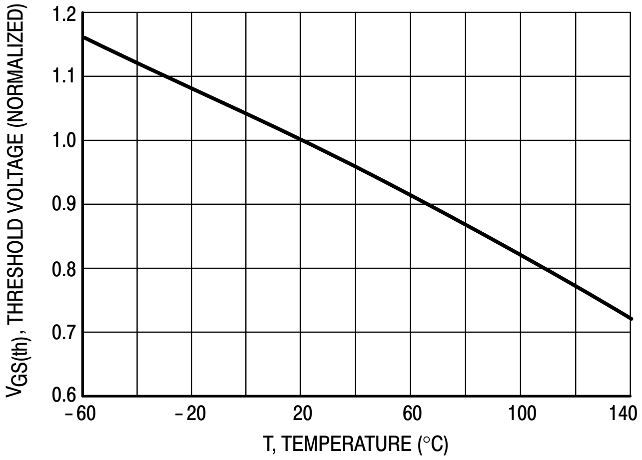
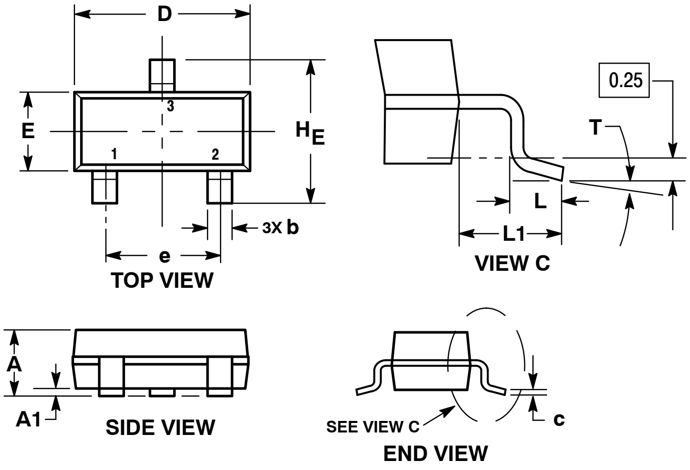


Figure 10. Temperature versus Gate Threshold Voltage

PACKAGE DIMENSIONS

SOT−23 (TO−236)
CASE 318−08
ISSUE AS

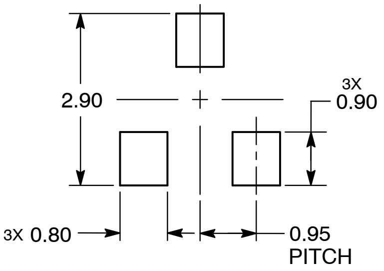


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

	MILLIMETERS			INCHES		
DIM	**MIN**	**NOM**	**MAX**	**MIN**	**NOM**	**MAX**
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080
L	0.30	0.43	0.55	0.012	0.017	0.022
L1	0.35	0.54	0.69	0.014	0.021	0.027
H_E	2.10	2.40	2.64	0.083	0.094	0.104
T	0°	−−−	10°	0°	−−−	10°

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

RECOMMENDED SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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